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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/015,433	12/12/2001	Martin Kranz	5318/CALB/COPPER/PJS	5742

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APPLIED MATERIALS, INC.
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SANTA CLARA, CA 95050

EXAMINER

TRAN, BINH X

ART UNIT	PAPER NUMBER
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1765

DATE MAILED: 05/12/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/015,433

Applicant(s)

KRANZ ET AL.

Examiner

Binh X Tran

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 12 December 2001.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-31 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-31 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s) _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2 6) ☐ Other: _____

DETAILED ACTION

Double Patenting

1. Applicant is advised that should claim 20 be found allowable, claim 21 will be objected to under 37 CFR 1.75 as being a substantial duplicate thereof. When two claims in an application are duplicates or else are so close in content that they both cover the same thing, despite a slight difference in wording, it is proper after allowing one claim to object to the other as being a substantial duplicate of the allowed claim. See MPEP § 706.03(k).

Claims Interpretation

2. In claim 7, the examiner reserves the right to interpret "the at least partially exposed layer" includes any exposed layer on the substrate since the applicants does not indicate that "the at least partially exposed layer" must comprise copper.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4. Claims 1-3, 5-6, 10-12, 16 are rejected under 35 U.S.C. 102(e) as being anticipated by Chou et al. (US 6,337,277).

Chou discloses a method comprising:

disposing the substrate (24) on a substrate support member in a process chamber (col. 8 lines 26-45);

cooling the substrate to less than -10°C (read on "cooling the substrate at least to a temperature of 100 degree Celsius"; col. 8 lines 46-50, Fig 2 step 54);

exposing the substrate to a pre-clean process, col. 9 lines 23-67).

Respect to claim 2, Chou discloses the step of electrostatically chucking the substrate to the substrate support member (col. 7 lines 45-49). Respect to claim 3, Chou discloses flow a gas through the substrate support member to an area between the substrate support member and the substrate (24) (Fig 1). Respect to claim 5, Chou discloses transferring heat from the substrate through the substrate support member to a coolant (read on "heat transfer fluid"; col. 6 lines 48-67). Respect to claim 6, Chou discloses cooling the substrate to -10°C more particular -20 to -40°C (within applicants' range, col. 6 lines 60-65).

Respect to claim 10, Chou discloses the plasma is formed from a gas comprising argon (col. 9 lines 40-42). Respect to claim 11, Chou discloses the top electrode is inductive electrode using RF power of 400 Watts to 800 Watts (col. 5 lines 50-53 and col. 13 lines 3-6; within applicants' range of 1-1000 Watts). Chou further discloses the biasing the substrate support with a power of 50-200 Watts and a pressure of 6-20 mTorr (read on "less than about 300 Watts" and "0.5-100 mTorr" col. 13 lines 1-6).

The limitation of claim 12 has been discussed above. Respect to claim 16, Chou discloses the plasma comprises argon, nitrogen or helium (col. 9 lines 40-42).

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chou in view of Maxwell et al. (US 5,996,353).

Chou fails to disclose transferring heat from the substrate through the thermoelectric device. However, Chou clearly discloses the step of transferring heat from the substrate. Maxwell disclose the use of thermoelectric device for transferring heat. It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Chou in view of Maxwell by using the thermoelectric device because it will help this allow a high control of temperature.

7. Claims 7-9, 13-15, 17-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chou in view of Subrahmanyam et al. (US 6,107,192).

Respect to claim 7, Chou fails to disclose the step of etching native copper oxide from the exposed layer. Subrahmanyam discloses the step of etching native copper oxide from the exposed layer (col. 6 line 59 to col. 7 line 24). It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Chou in view of Subrahmanyam by etching the native copper oxide from the exposed layer because it will remove contaminants prior to metallization.

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The limitation of claim 8 has been discussed above under Chou's reference. Respect to claim 9, Subrahmanyam discloses flow a reactive gas (i.e. O₂, CF₄ or NF₃) into chamber to reduce native oxides. It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Chou in view of Subrahmanyam by flowing the reactive to reduce native oxide gas because it will remove contaminants prior to metallization.

Respect to claim 13, Chou fails to disclose cooling the substrate in a degas chamber. However, Chou clearly discloses the step of cooling the substrate in a chamber. Subrahmanyam discloses the step of cooling the substrate in a degas chamber (170) (col. 10 lines 48-52). It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Chou in view of Subrahmanyam by cooling the substrate in the degas chamber because it will help to remove gas contaminants.

Respect to claim 14, Chou fails to disclose cooling the substrate in a cool down chamber. Subrahmanyam disclose the step of cooling the substrate in the cool down chamber (176) (col. 10 lines 31-45). It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Chou in view of Subrahmanyam by cooling the substrate in the cool down chamber because this allow the substrate be process or cooled in any number of times.

Respect to claims 15, 17, Chou fails to disclose the step of flowing a reactive gas into the chamber to reduce native oxide. Subrahmanyam discloses flowing a reactive gas into the chamber to reduce native oxide (col. 7 lines 48-55). It would have been

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obvious to one having ordinary skill in the art, at the time of invention, to modify Chou in view of Subrahmanyam by flowing reactive gas into the chamber to reduce native oxide because it provide an oxygen free interface between the feature and the sub0layer which reduces the resistance of the features.

Respect to claim 18, Chou fails to disclose the step of exposing the partially exposed copper layer to a pre-clean process at a temperature of less than 100 °C and depositing a copper bulk layer on the partially exposed layer. However, Chou clearly discloses the step of pre-cleaning an exposed layer at the temperature below 100 °C. Subrahmanyam teaches exposing the partially exposed copper layer to a pre-clean process as well as depositing a bulk layer of copper on the partially exposed layer. It would have been obvious to one having ordinary skill in the art, at the time of invention, to expose the copper to a pre-clean process and forming a copper bulk layer on the exposed layer because it will clean the via without sputtering of the base of the via.

Respect to claim 19-21, Subrahmanyam discloses the barrier layer is make of TiN and TaN (col. 8 lines 8-20).

The limitation of claim 22 regarding two chambers has been discussed above (i.e., degas chamber or cool-down chamber). Respect to claim 23, Chou discloses providing backside gas between the substrate and a substrate support (col. 7 lines 55-61). The limitation of claim 24 has been discussed above. Respect to claims 25-26, Subrahmanyam discloses the step of transferring the substrate to the third processing chamber (175) and depositing a barrier layer of titanium nitride on the at least exposed layer (col. 10 lines 50-60). Respect to claim 27 both Chou and Subrahmanyam disclose

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the pre-clean process comprise non-reactive gas such as argon or He. The limitation of claim 28 has been discussed above in Chou's reference.

Respect to claim 29, Subrahmanyam discloses the plasma etch remove contaminant without redeposition of metal on the surface or without sputtering of the base of the via (read on "without causing copper agglomerations on via surface", col. 6 lines 59-67 and col. 8 lines 32-39). Respect to claim 30, both Chou and Subrahmanyam disclose the pre-clean process include reactive gas. Respect to claim 31, Subrahmanyam discloses the step of depositing a barrier layer on the partially exposed and pre-clean the copper feature.

8. Claims 19, 27-28, 30-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chou and Denning et al. of each other (US 6,451,181).

Respect to claim 19, Denning disclose the step of:

disposing the substrate (22) on a substrate support member in a process chamber (10) (col. 13 lines 29-35);

exposing an at least partially exposed copper layer (202a) on the substrate to a pre-clean process (col. 13 lines 48-67);

depositing a barrier layer on the at least partially exposed copper layer (step 412, Fig 12).

Denning fails to disclose the step of cooling the substrate to a temperature of at least 100 °C. Chou discloses the step of cooling the substrate less than equal to -10 °C (read on "cooling the substrate to a temperature of at least 100 °C". It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Denning

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in view of Chou by cooling the substrate to the temperature below 100 °C because this would protect the sidewall during cleaning. Respect to claim 20-21, Denning discloses the step of depositing a barrier layer of tantalum nitride (col. 15 lines 45-51).

Respect to claim 27, Chou disclose the method comprising the steps of:

depositing the substrate on a substrate support member within a process chamber maintained at a chamber pressure of 6-20 mTorr (within applicants range, col. 12 line 67 to col. 13 line 2);

cooling the substrate between -20 °C to -40° C by maintaining a gas between a surface of the substrate support and a facing surface of the substrate to transfer heat from the substrate to the support member (col. 7 lines 55-60 and col. 8 lines 46-55);

performing a pre-clean process comprising a plasma comprising non-reactive gas (i.e., argon, He).

Chou fails to disclose exposing the partially exposed copper feature to a pre-clean process gas. Denning discloses the step of exposing the partially exposed copper feature to the pre-clean process gas. It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Chou in view of Denning by exposing the partially exposed copper to the pre-cleaning process gas because it will help to remove contaminant while minimize the copper removal from the surface.

The limitations of claims 28, 30 have been discussed above. Respect to claim 31, Denning discloses the step of depositing a barrier layer (step 412 Fig 12) and pre-cleaned copper feature (step 408 Fig 12).

Conclusion

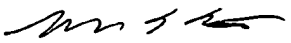
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9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Binh X Tran whose telephone number is (703) 308-1867. The examiner can normally be reached on Monday-Thursday and every other Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on (703) 308-3836. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9310 for regular communications and (703) 872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.

Binh X. Tran
May 8, 2003


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